PRODUCTION OF HYDROGEN FROM GASIFIED COAL AND LASER FUSION ATOMIC ENERGY

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This paper is a presentation of the case for the immediate construction of a commercial size plant for the production of hydrogen from coal and nuclear energy. Hydrogen is the ideal source of energy for space heating and for electric power. Since hydrogen burns to water, power sources using this fuel will not pollute the atmosphere. There are important savings when energy is transmitted as hydrogen rather than as electric current. A standard cubic foot of hydrogen contains more energy than an equal volume of other gaseous fuels. The cost of transmitting hydrogen by pipe line will be low, in part due to the availability of instruments which can quickly detect infinitesimal amounts of leaking gas. It is possible to economically ship hydrogen by pipe line for at least a thousand miles.

Altho electricity can be transmitted over high voltage lines for about 500 miles, the energy losses in transmission are substantial. Hydrogen will also be preferred by environmentalists when compared to electric power. Hydrogen pipe lines will be underground, and farming operations can be carried out over them. On the other hand high voltage power lines are unsightly and cause many difficulties to families who live near them.

The ideal electric power supply will be a hydrogen air fuel cell system. (1) The D. C. power produced will be transmitted through sodium filled plastic tubes. These power conductors can be located underground. Since the electricity will be produced close to the electric power consumer, transmission line losses will be small. Replacing copper conductors with sodium conductors will result in substantial capital cost savings.

Hydrogen is now used to make ammonia and a cheaper source of hydrogen is necessary before it can be used to make electricity. The cooperative action of two sources of energy is necessary for the production of cheap hydrogen. These two sources are laser induced nuclear fusion and bituminous coal. The fusion energy plant design is to be based on a Lawrence Livermore laboratories 1000 megawatt power plant. (2) The coal energy plant design follows U.S. Steel's Clean-Char process. (3) Figure 1. Steam plus the clean fuel gas and clean char from U.S. Steel's process are the principal raw materials for the production of cheap hydrogen.

Photochemical energy for the endothermic carbon steam reaction is to be obtained from micro H bomb explosions. The radiant energy from the micro H bomb is to be absorbed by a steam fogged mixture of barium hydroxide and char as shown in Figure 2. The overall process equation is

$$BaO + C + 2\,H_2O \longrightarrow BaCO_3 + 2H_2. \qquad 1)$$

Equation 1) is similar to the CO_2 acceptor process (4), except that BaO is substituted for CaO. Using barium instead of calcium will allow complete absorption of the fusion energy. The reaction chamber will need to be large enough to absorb the x-rays produced by the micro H bomb gamma rays. In aqueous environments the principal end results of x-ray absorption is rupture of hydrogen oxygen bonds.

This photochemical process can be regarded as a first order reaction with resulting high efficiency and low cost.

As shown in Figure 3 the raw materials for the micro H bomb are deuterium, tritium and helium-3. Tritium and helium-3 can be recovered from the micro H bomb explosion out gases. Altho deuterium can be purchased it will probably be manufactured on site from river water and energy derived from burning coal. The by-product from the micro H bomb explosion is Helium-4. It can be separated from the explosion out gases by passage through an ultra centrifuge.

The cost of the hydrogen produced can be substantially reduced by the sale of by-products from U.S. Steel's Clean Char process. (3) A wide variety of by-products based on compounds derived from carbon, nitrogen or sulfur are available. There should be sufficient flexibility in the hydrogen manufacturing processes, so that the by-product mix can be varied to suit varying market conditions. Most probably the nitrogen and sulfur will go into fertilizers. Most carbon compounds will be used for fuel, but some of the hydrocarbon by-products may be upgraded and sold as raw materials for plastic production.

Substantial capital investments are necessary before heat and power can be enjoyed by consumers. Coal must be located, separated from the earth, processed and transported. Hydroelectric power also requires large investments for the production and transmission of electricity. Investments in hydroelectric power systems are considered by many, to be one of the best hedges against the inflationary erosion of the purchasing power of the dollar. Nuclear power plants are still more capital intensive that steam or hydro power plants, and also can be considered as inflation hedges.

TABLE 1

CAPITAL COSTS

1973 ESTIMATES; ELECTRIC POWER DELIVERED TO THE EASTERN SEABOARD

TYPE OF PLANT	DOLLARS PER KW OF POWER CAPABILITY
NO POLLUTION FUEL OIL PLANT	350
COAL FIRED PLANT	400
NO POLLUTION COAL FIRED PLANT	550
FISSION NUCLEAR PLANT	700
FUSION NUCLEAR PLANT	650

Environmental and pollution considerations importantly effect both the operating and capital costs of power plants. Table one shows that the addition of anti-pollution equipment to a coal fired electric power plant increases the capital cost by 37%. The capital costs of a fusion nuclear power plant are estimated to be slightly lower than those of a fission nuclear power plant. Capital costs for hydrogen production will run parallel to capital costs for power production. For hydrogen production, fusion energy should be cheaper than fission energy.

The input requirements of the plant shown in Figure 2 are Appalachian bituminous coal, pure water, and energy. Pure water and electricity are also required for the production of deuterium which is the principal raw material for the production of energy by atomic fusion. Pipe line hydrogen, as shown in Figure 2, is the final product of the hydrogen production process.

In the ultimate ideal situation everyone will heat his house with pipe line hydrogen, or with electricity locally generated from hydrogen. This ideal cheap fuel abundance has been called a hydrogen fuel economy. The plant investment necessary to fuel the furnaces of American with hydrogen is enormous. It will probably take 25 years to find enough money to build the plant and mining facilities necessary for the United States hydrogen fuel economy. The first commercial hydrogen plants will be forced to find markets for their product which will be more lucrative than the space heating which is required by the hydrogen economy. Examples of such markets are production of:

a. methanol for manufacture of lead free high octane gasolene
b. hydrazine for peak power, pollution free, electric fuel cells
c. methane for upgrading 500 BTU coal gas into 1000 BTU SNG
d. sulfur free fuel oils for pollution free electric plants.

All nations who have the necessary technical capabilities are diligently working on the problem of initiating nuclear fusion by concentrating intense energy from lasers. The aim is to ignite a tiny pellet of hydrogen like material so that a micro H bomb explosion will result. If the expenditure of billions of dollars guarantees success, the United States should be the winner in the world wide atomic fusion sweepstakes.

Fusion ignition energy requirements are very large. A high temperature, high pressure laser should be capable of generating the required power levels. It ought to have an efficiency of 50% and be of the Excimer type. Its output should be in a wavelength area between 2000 and 10000 Angstroms. It is probable that the successful laser will operate in the midrange or at a wavelength of approximately 300 nanometers. The output of the laser should be 10^{12} watts, and the length of the output pulse should be 10 picoseconds. Even with an output of this magnitude, it will be necessary to hit the deuterium pellet with an array of lasers fired simultaneously.

Figure 4 is a schematic diagram of a laser proposed for fusion initiation. Energy is injected into the lasing tube by a traverse electron avalanche. The power flash of the laser breaks the output mirror, thus allowing the high power pulse to leave the lasing tube.

The micro H bomb explosions will occur at 25 or less pulses per second. After each explosion a new aluminum mirror on thin plastic sheet will be positioned over the exit port. The distance between the two lasing mirrors is then adjusted by varying the gas pressure on the upper mirror sheet until correct focus is obtained. Coherent light from the laser is concentrated onto the pellet by fused silica lenses. These lenses are maintained in a vacuum by the shot chamber vacuum system. The second or lower mirror in the lasing tube is figured in a blank which can be water cooled. The optics of the lower mirro are designed to minimize damage to the mirror, and to work with the coherent light concentrating optics.

Hydrogen can be produced by the proposed photochemical process for much less than the cost of electrolytic hydrogen. In addition the break even point for gamma and neutron ray hydrogen production is an order of magnitude better than the fusion electric power break even point.

The construction of a full size AEC approved deuterium pellet factory should be initiated at once. Concurrently contracts for model production and testing of TEA UHP lasers should be let. Hydrogen plant site preparation should be included in the contract to be placed for the construction of a U.S. Steel Clean-Char coal gasification plant. In the near future, UHP lasers will be commercially available. It would then be possible to proceed without delay with the construction and operation of a laser fusion hydrogen plant.

Now is the time to proceed with the commercial production of hydrogen from gasified coal and laser fusion atomic energy. The demonstration hydrogen plant must be built close to coal deposits. Also it must be situated on the banks of a river which will supply large volumes of soft water for all 12 months of every year of the projected life of the plant.

REFERENCES

(1) Chem. & Eng. News 52 Fuel Cell Research Finally Paying Off, page 31, Jan. 7, 1974.

(2) Nuckolls, Emmett, Wood, Physics Today, 26, page 47, Aug. 1973.

(3) Chem. & Eng. News 52 Processes Lower Sulfur Content of Coal, page 28, April 8, 1974.

(4) Chem. & Eng. News. Energy: The Squeeze Begins, page 33, Nov. 13, 1972.

Clean-Char process leads to low-sulfur fuel

FIG 1

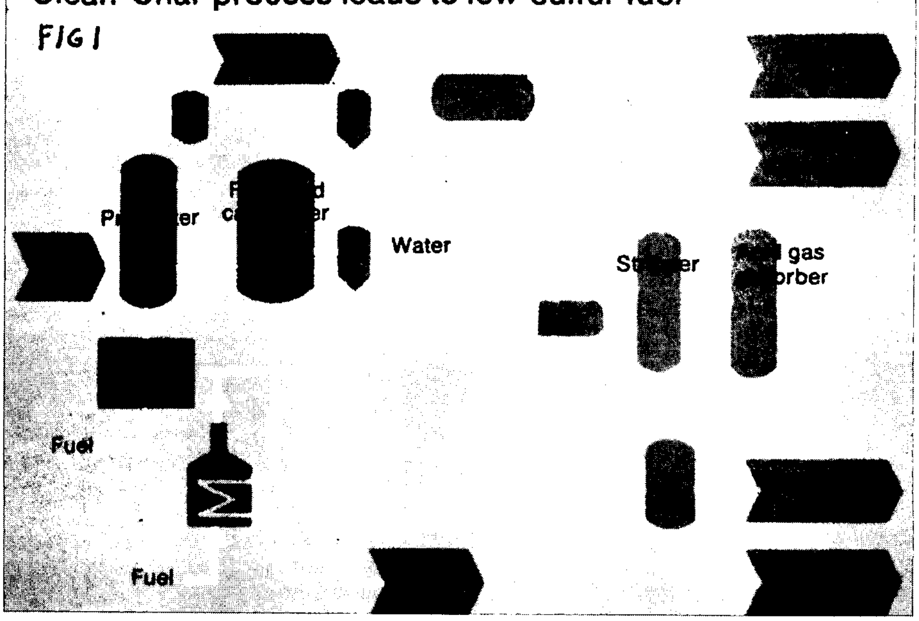

FIG 2

FUSION HYDROGEN PLANT

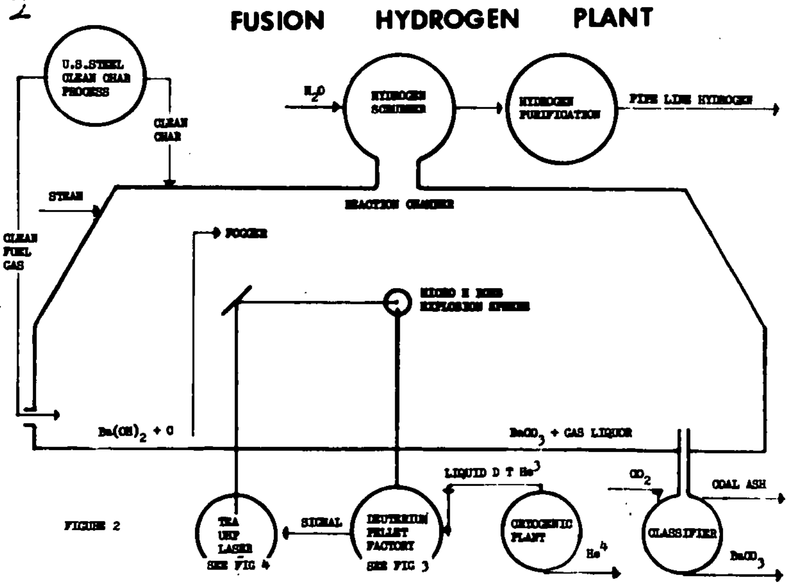

FIGURE 2

FIG 3

FIGURE 3
DEUTERIUM PELLET
FACTORY

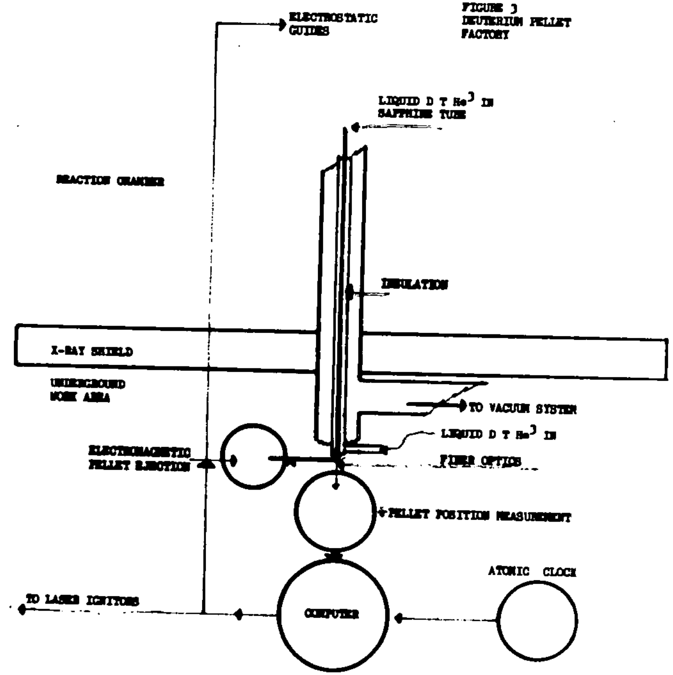

FIG 4

TRAVERSE ELECTRON AVALANCHE
ULTRA HIGH POWER
EXCIMER LASER